

What is claimed is:

1. A heat transfer system which comprises:
 - a supply tube having a proximal end and a distal end;
 - a capillary tube having a proximal end and a distal end, with said proximal end thereof connected in fluid communication with said distal end of said supply tube;
 - a tip member positioned to surround said distal end of said capillary tube forming a cryo-chamber therebetween;
 - a source of refrigerant fluid, connected in fluid communication with said proximal end of said supply tube;
 - a means for introducing the refrigerant fluid into said supply tube at a working pressure " p_w ", for transfer of the refrigerant fluid through said supply tube and through said capillary tube to exit from said distal end of said capillary tube and into said cryo-chamber in a substantially liquid state, for transition of the refrigerant fluid into a gaseous state with a tip pressure " p_t " and a tip temperature " T_t ", for heat transfer through said tip member and into the gaseous fluid refrigerant in said cryo-chamber;
 - a temperature sensor for measuring the tip temperature " T_t "; and
 - a means connected to said temperature sensor and to said introducing means for controlling said working pressure " p_w " according to the tip temperature " T_t " to minimize the tip temperature " T_t ."
2. A system as recited in claim 1 wherein said refrigerant fluid is nitrous oxide (N_2O).
3. A system as recited in claim 1 wherein said working pressure " p_w " is in a range between three hundred and fifty psia and five hundred psia.

4. A system as recited in claim 1 wherein a pressure regulator is in fluid communication with said source of said fluid refrigerant and said controlling means.

5. A system as recited in claim 1 wherein said temperature sensor is mounted on an interior surface of said tip member.

6. A system as recited in claim 1 wherein said temperature sensor is mounted on said distal end of said capillary tube.

7. A system as recited in claim 1 wherein said tip pressure " p_t " is less than one atmosphere.

10 8. A system as recited in claim 1 wherein the tip temperature, " T_t ", is less than minus eighty-four degrees Centigrade ($T_t < -84^{\circ}\text{C}$).

9. A system as recited in claim 1 wherein said controlling means is a system controller which comprises: a signal receiver, a processor, and a pressure control algorithm.

10. A heat transfer system which comprises:
a means for providing a liquid refrigerant at a first pressure;
a means for reducing the pressure on said liquid refrigerant from
said first pressure to a second pressure;
5 a means for introducing said liquid refrigerant into a cryo-
chamber at said second pressure for transition of said liquid refrigerant
into a gaseous state in said cryo-chamber to cause heat to transfer
from outside said cryo-chamber, into said cryo-chamber;
a means for sensing a temperature in said cryo-chamber; and
10 a means connected to said sensing means and to said
introducing means for controlling said first pressure according to the
temperature in said cryo-chamber to minimize the temperature in said
cryo-chamber.
11. A system as recited in claim 10 wherein said liquid refrigerant is
15 nitrous oxide (N₂O).
12. A system as recited in claim 10 wherein said reducing means
comprises:
a supply tube having a proximal end and a distal end; and
a capillary tube having a proximal end and a distal end, with the
20 proximal end thereof connected in fluid communication with the distal
end of said supply tube.
13. A system as recited in claim 10 wherein said sensing means is a
temperature sensor mounted in said cryo-chamber.
14. A system as recited in claim 12 wherein said sensing means is a
25 temperature sensor mounted on said distal end of said capillary tube.

15. A system as recited in claim 10 wherein said means for controlling said first pressure comprises: a system controller, a processor, a pressure control algorithm, and a pressure regulator.

5 16. A method for transferring heat which comprises the steps of:
providing a liquid refrigerant at a first pressure;
reducing the pressure on said liquid refrigerant from said first pressure to a second pressure;
introducing said liquid refrigerant into a cryo-chamber at said second pressure for transition of said liquid refrigerant into a gaseous state in said cryo-chamber to cause a transfer of heat from outside said cryo-chamber, through a tip, and into said cryo-chamber;
10 sensing a tip temperature, " T_t ";
electronically communicating said tip temperature " T_t " to a system controller; and
15 controlling said first pressure according to said tip temperature " T_t " to minimize said tip temperature, " T_t ".

17. A method as recited in claim 16 wherein said liquid refrigerant is nitrous oxide (N_2O).

20 18. A method as recited in claim 16 wherein said first pressure is a working pressure " p_w " in a range between three hundred and fifty psia and five hundred psia, and said second pressure is a tip pressure " p_t " of less than one atmosphere.

19. A method as recited in claim 16 wherein the tip temperature " T_t " is less than minus eighty-four degrees Centigrade ($T_t < -84^\circ\text{C}$).

20. A method as recited in claim 16 wherein said controlling the first pressure step comprises the steps of:

receiving a tip temperature " T_t " from a temperature sensor;

processing a control algorithm;

5 calculating an adjustment to said first pressure; and

controlling said first pressure.